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## EGG PHOTOGRAPHS DEPICTING 40 SPECIES OF SOUTHERN AUSTRALIAN MOTHS

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### INTRODUCTION

THE 48 FIGURES IN THIS PAPER were selected primarily to show some of the *diversity in egg form and mode of deposition* among different families of "Macro" moths (Figs. 1-20), and to illustrate this yet again for a single family, the Geometridae (Figs. 21-48). Most of these eggs were obtained from captive moths, using techniques described in earlier papers (McFarland 1964, 1965). All species depicted here are represented by identically code-numbered preserved eggs, larvae, and pupae in alcohol, empty (dry) egg shells, cocoons (on pins), associated adults, and occasional parasites, all of which are deposited in the Entomology Dept. of the South Australian Museum, North Terrace, Adelaide, South Australia 5000. The (McFarland) code-number for each species appears at the beginning of each commentary, opposite the name of the species. The egg measurements are given at the end of each commentary (where available), in *diminishing maximums*, as discussed at length in the preceding paper. For accuracy, only the recorded measurements should be compared; the sizes of the eggs in different photographs do not always reflect their sizes *relative* to each other. With the exception of Figs. 41-48, all photographs are by the author, and all show unhatched *living* eggs. Figs 1-40 were taken on 35mm. black-and-white film (various brands and speeds), using the Japanese (S.L.R.) Topcon RE. Super camera, with through-the-lens light metering. The camera body (minus lens) was attached (by a specially-adapted tube) to the Japanese Nikon SMZ-2 binocular microscope with zoom lens. In all cases *bright morning sunlight* was used as the (only) light source; details of this photographic technique are given in the preceding paper.

**LOCALITIES:** Most of the adult females confined for eggs were attracted to one 15-watt unfiltered ultraviolet light (the "black light", G.E.F15T8.BL), in a garden at 2 Gulfview Road, BLACKWOOD, SOUTH AUSTRALIA (836 feet elevation), in the foothills of the Mount Lofty Range, about 7 miles south of Adelaide, where I was living from Jan. 1965 to Sept. 1970. All eggs illustrated (except Fig. 9) represent species occurring within a short distance of the city of Adelaide. Many of these species, or close relatives, are known also from other parts of southeastern Australia (Victoria, Tasmania, New South Wales, and southern Queensland), and from the southwest of Western Australia in several cases. The exact locality is given, for all eggs illustrated, at the beginning of each commentary, along with the recorded months of adult occurrence *in that locality*.

As a matter of interest to readers in other countries, the four seasons in South Australia can be interpreted as follows: SEP.-NOV. = *SPRING* (cool to warm; wet grading to dry); DEC.-mid MAR. = *SUMMER* (cool to hot; mostly *dry*); late MAR.-mid MAY = *AUTUMN* (warm to cold; dry grading to wet); late MAY-AUG. = *WINTER* (mild to cold; mostly *wet*). October in coastal South Australia (near Adelaide), or in the south of Western Australia (near Perth), corresponds roughly to April in coastal California south of San Francisco. The climate approximates the (coastal) Mediterranean type, with a cool wet season and a (mostly) warm to hot dry season. *Average annual rainfall* (based on 41 years of records, 1929-1969) is 26.75 inches (2675 points) at Blackwood, South Australia, where most of the illustrated species occur. Annual precipitation as high as 38 inches (1968) and as low as 14 inches (1967), has been recorded during this 41 year period (records in the Blackwood Post Office). Snow never falls here, except for traces (once or twice each winter), only in the Mt. Lofty summit area. *Temperatures:* Diurnal summer highs rarely surpass 102°F. in the Blackwood vicinity (usually in the 70's, 80's or low 90's), and nocturnal winter lows rarely drop below 34-35°F.

The native plants of the Blackwood-Belair-Eden Hills district of the Mt. Lofty Range compose a variable forest-and-scrub mixture of sclerophyll trees, shrubs, dwarf shrubs, grasses, and annual herbaceous plants, etc. Of the larger spp., *Eucalyptus odorata* Behr. ex Schldl., *E. leucoxylon* FvM. (Myrtaceae), and *Acacia pycnantha* Benth. (Mimosaceae) predominate in the Gulfview Road locality. There is also an extensive

introduced (naturalized) element; many of these are highly aggressive "weeds" here, to the great detriment of the dwindling (smaller) native plants. Prime examples, in this locality, are the woody South African shrub, *Chrysanthemoides monilifera* (L.) T. Norl. (Asteraceae), various blackberries, *Rubus* spp. (Rosaceae), and the European olive (Oleaceae), among others. *Homo sapiens* will predictably wipe out most of the little that remains (of the smaller and unique native flora) in the Blackwood-Belair district during the next two or three decades, if *C. monilifera* does not finish the job first.

**DATES:** In the following commentaries, dates should be interpreted as follows: "early" = the 1st through the 10th of the month; "mid" = 11th through 20th; "late" = 21st through 31st. In a case reported as "late MAY-JULY", the implication is that I have records for *all periods through* the month of July (early-mid-late); if this were not so, it would state "late MAY-early JULY" or "late MAY-mid JULY". The first of the date-periods recorded (as "late MAY", in the above example) represents the beginning of the flight (my earliest records for adult occurrence in the locality named); the latter part (as *late* July, in the example) represents the apparent end of the flight, when the species has past its peak and only occasional (usually worn) specimens are being encountered. All Blackwood flight records are based on 5½ *consecutive* years of collecting and observation in that locality.

**DETERMINATIONS:** All determinations are based on the associated adults (those bearing McFarland code-numbers on blue labels). Most of these have been compared with the type specimens. Determinations are cited as follows: DSF = D. S. Fletcher and assistant, K. Brookes, British Museum (Nat. Hist.), London; IFC = I.F.B. Common, Div. of Entomology, C.S.I.R.O., Canberra; NBT = N. B. Tindale, formerly of the South Australian Museum, Adelaide; NM = Noel McFarland (when on the staff of the S.A. Museum.) Code-numbered duplicate *adult* specimens of most of these species have been donated to the Australian National Insect Collection (Canberra), and to the British Museum (N. H.), during the course of this study.

The 40 species illustrated here, along with about 180 additional species, most of which represent more-or-less complete life history studies (all or most stages preserved), are deposited in the South Australian Museum, North Terrace, Adelaide, and

are available for loan to qualified specialists. To facilitate handling, and to insure accuracy, they should always be asked for *by code-number*. An "index" booklet exists, arranged by family, listing the code-numbers (and names if known) for all species in the collection.<sup>1</sup> Most of the South Australian material is dated between JAN. 1965 and DEC. 1971. Identically code-numbered notes (often extensive), plus black-and-white photographs, accompany most of the species. These notes and photos always emphasize features connected with the *living* insects—*whatever will be lost once they are killed*—such as color descriptions based upon the living specimens, characteristics of the habitat, ecological relationships (parasites, etc.), cryptic forms and the significance of their coloration (resting positions of adults and larvae, etc.), displays or reactions to disturbance, and any other observed details of behavior.

**FOODPLANTS:** To save repetition (and space) it was decided to omit any mention of foodplants in this paper, as a detailed paper on foodplant records (many new) is now in preparation; this will cover all but one of the 40 species illustrated here, plus numerous other southern Australian moths.

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<sup>1</sup> Copies of this booklet (up to date through Dec., 1970) are deposited at the Entomology Dept., South Australian Museum (Adelaide); the Entomology Dept., Los Angeles County Museum, c/- J. P. Donahue (California); the Zoology Dept., Univ. of Florida, c/- T. C. Emmel (Gainesville); the British Museum (Nat. Hist.) c/- D. S. Fletcher (London). The original copy, constantly being added to, is kept by the author.

## COMMENTARIES ON THE PHOTOGRAPHS

### *Figs. 1-20: Thirteen Non-geometroid Moth Families*

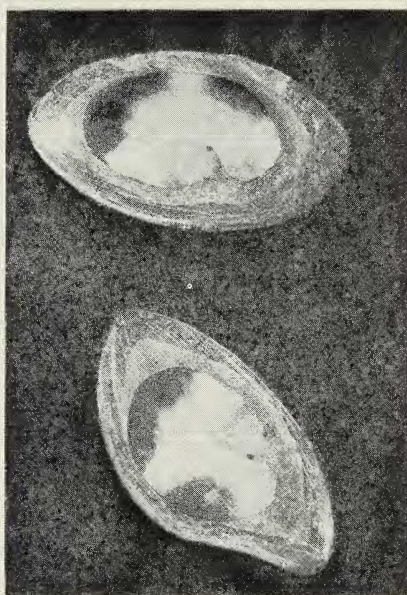
#### Superfamily HEPIALOIDEA

#### Family HEPIALIDAE

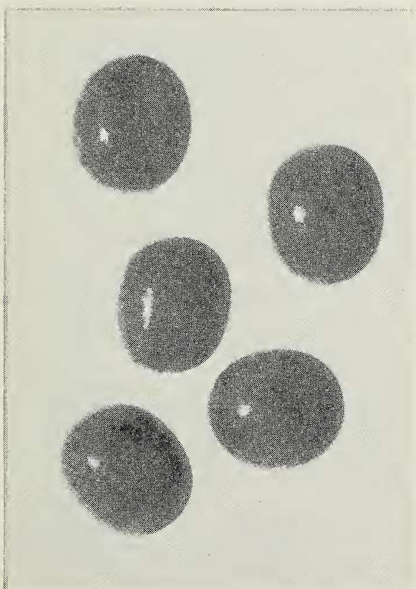
Fig. 1: *Aenetus blackburni* Lower (det. NBT) Hp.35(M) (Blackwood and Eden hills, South Australia; late MAR.-early APR. only). These eggs are scattered and dropped free by the female during oviposition (in no way attached). This is the typical mode of oviposition among the Hepialidae. Some hepialid eggs are more or less perfect spheres, and the shell is usually rather pliable and easily dented. When freshly deposited the eggs of this species are pure white, but they soon become opaque black. Considerable collapse of the shell took place



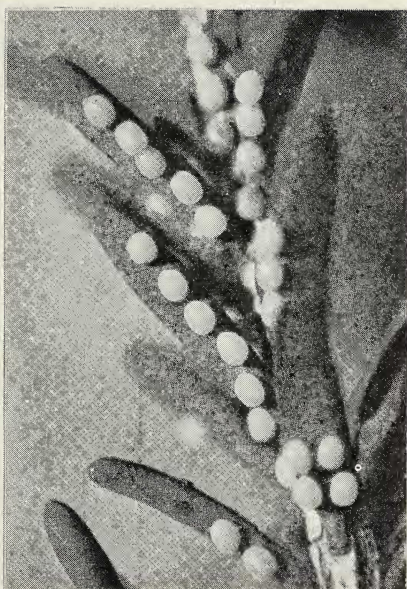
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during development, but the young larvae hatched successfully. (This may be a normal occurrence during incubation?) Took 24 days to hatch (autumn).

Size = 0.75-0.70 mm. x ?

Spf. ZYGAENOIDEA

Fam. ZYGAENIDAE

Fig. 2: *Hestiochora rufiventris* (Walker) (det. DSF) Zy.8A (43 mi. W. of Eucla, Nullabor Plain, Western Australia; late NOV.-DEC.  $\pm$ ). As in many (perhaps all?) other zygaenoids, the eggs are notably soft-shelled (very easily dented or damaged). They are attached in long series up and down the small leaves and twigs of the foodplant, entirely naked and closely end-to-end, but rarely in actual contact. They are very obvious if present on the foodplant. Color, pale translucent yellowish. Took between 7-10 days to hatch (summer).

Size = 0.65-0.60 x 0.55-0.50 x 0.45-0.40 mm.

Fam. LIMACODIDAE

Fig. 3: *Doratifera oxleyi* (Newman) (det. IFC) Lm.5 (Blackwood, South Australia; mid MAR.-mid APR.; ♀ adult nocturnal, ♂ adult diurnal). The shells are very soft and easily broken; it is almost impossible to separate these delicate eggs without damaging them. They are extruded either in long chains, as shown, or in rounded masses of various sizes, lightly-coated with soft, pale brown "fluff" (scales) from the female abdomen. Heavily-laden females (probably recently finished mating) have a tendency to extrude their earliest eggs naked in long, straight or undulate chains, rather than ovipositing in masses. This is particularly evident among fresh females attracted to light, where they frequently extrude "egg chains" while sitting on the wall. Color translucent yellowish; surface shiny.

Fig. 4: *Pseudanapaea trigona* (Turner) (det. IFC) Lm.3 (Blackwood, South Australia; OCT.-mid MAY). The photograph shows two eggs, close to hatching, as seen from the underside. (They were deposited on a thin sheet of clear plastic, and photographed through it, over a dark background). The small larvae are clearly visible inside the colorless and transparent shells. The shells are exceedingly thin, pliable, and easily ruptured. In nature, they are attached singly to the foodplant leaves, appearing (at first) like tiny, clear, flattened

droplets of water, barely visible when viewed from above; later, they could be mistaken for *shiny* scales adhering to the leaves. When being deposited by the moth, they are so soft and flexible that individual eggs often have *entirely different shapes*, depending upon the angle of contact of the moth's abdomen with the substrate, and the pressure exerted, at the moment of oviposition! Thus, only "average" measurements of egg length and width can be made for this species. *Of all insect eggs I have seen to date, this species would seem the ideal subject for anyone wishing to study larval development as it takes place inside the egg.* (See also the sixth paragraph of the paper that follows).

Size (approx., max.) = 2.30 x 1.40 x 0.30 mm.

#### Spf. PYRALOIDEA

##### Fam. PYRALIDAE, Subfamily EPIPASCHIINAE

Fig. 5: *Epipaschia pyrastis* (Meyrick) (det. IFC) Py.31(M) (Blackwood, South Australia; NOV.-APR.). According to D. J. Carter, this species is under the genus *Macalla* in the British Mus. (N.H.). These eggs are very much flattened, soft-shelled, and "scale-like", with a finely-pitted surface, resulting in a sparkling surface shine. They are deposited in distinctive flattened masses, like shingles on a roof, each one partially overlapping two or three of those in front of it. The photograph shows only a part of one mass, as attached to the foodplant leaf.

#### Spf. BOMBYCOIDEA

##### Fam. LASIOCAMPIDAE

Fig. 6. *Digglesia rufescens* (Walker) (det. DSF) La.18 (Blackwood, South Australia; DEC.-FEB. and MAY-JULY). Typical of most bombycoid eggs, the shells are very tough and firm. The eggs are securely glued to the surface, in this case a piece of stiffened muslin, which is ideal for causing many moths to oviposit in captivity. The white areas of the shell are opaque. When the eggs hatch, the dark areas will appear transparent on the empty shells, and the opaque white markings will remain behind, exactly as seen in the photograph. The general appearance and maculation of these eggs is typical of many other lasiocampid eggs. A batch obtained 22 DEC. 66 (summer) took 10 days to hatch; a batch obtained in early JULY 66 (mid winter) took 28 days to hatch. (Both batches were kept indoors, but at approximately the natural temperatures of the habitat, including day-night fluctuations).  
Size = 1.60 x 1.30 mm.

## Fam. ANTHELIDAE

Fig. 7: *Pterolocera* sp. (det. IFC) An.2A  
(10 mi. W. of Vivonne Bay, S. coast of Kangaroo Island, South Australia; mid MAR.-MAY). These eggs are very tightly glued to each other, wherever they contact along their sides. See the dried rings of colorless adhesive remaining attached on two eggs that have been broken off the main mass (upper right). The shells are opaque grayish-brown and very tough. This species occurs in brushy scrub, heath, or woodland areas, away from the immediate sea coast around Adelaide, and on Kangaroo Island. A closely-related species in the southwest of Western Australia (my An.10), has eggs quite different in coloration at the large end, although similar to these in general appearance and mode of oviposition.

Size = 1.55-1.45 x 1.25-1.20 mm.

Fig. 8: *Pterolocera* sp., close to *amplicornis* Walker  
(det. NM)

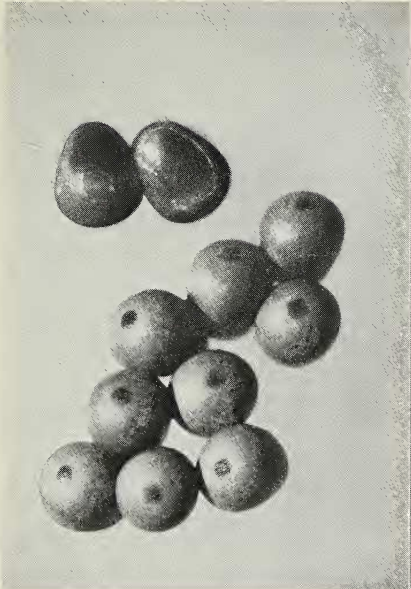
An.6

(Hallett Cove, S. of Adelaide, South Australia; APR.). The eggs of this species are apparently not deposited in masses like the preceding, although this needs further verification. The inset (upper right) shows the top (micropylar) end of an egg, at slightly higher magnification than the other three. The shells are opaque mottled with brown and white (no surface shine), and tough. The adult female moths of this genus are wingless. The adult males of this species (and the preceding) look rather similar at first glance, but clear-cut differences in the eggs of these two species are immediately obvious (in shape, maculation, and mode of oviposition). This species occurs in various (restricted) grassy localities near Adelaide, and on Kangaroo Island at Seal Bay (probably also elsewhere).

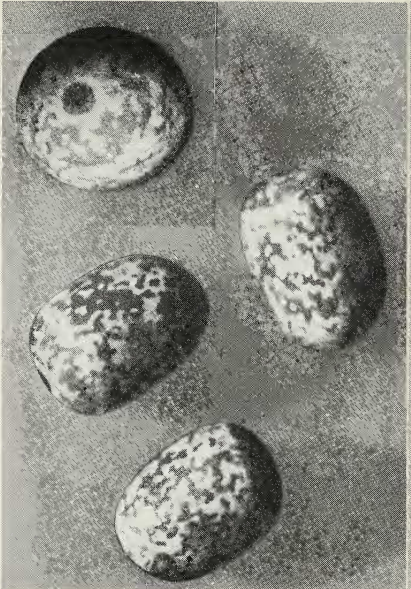
Size = 1.55 x 1.05-1.00 mm.

## Fam. CARTHAEIDAE (Common, 1966)

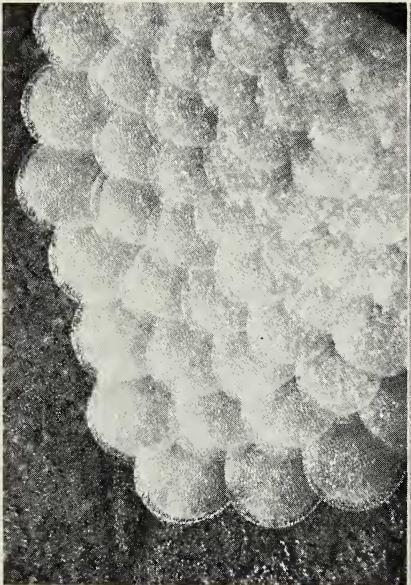
Fig. 9: *Carthaea saturnioides* Walker (det. NM) Ca.1  
(Stirling Range, near Toolbrunup Peak, Western Australia, in a roadside gravel quarry; late SEP.-early DEC.). For details on the larval, pupal, and adult stages of this superb moth, see Common (1966). The egg is at first a uniform light honey-yellowish, and relatively smooth, with a bright surface shine; prior to hatching it becomes black (the color of the larva showing through the colorless, transparent shell). The shell is not



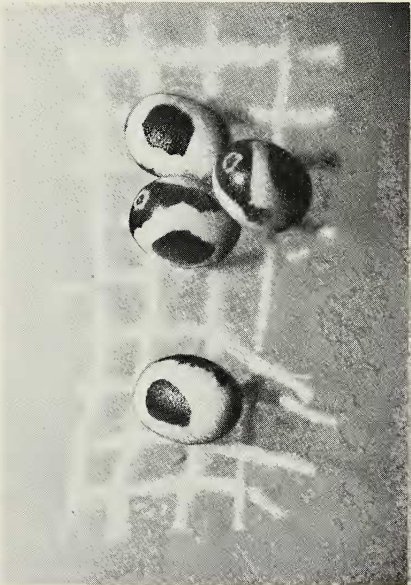
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6

as tough or rigid as in most *Bombycoidea*. They are usually glued irregularly in small groups (twos or threes), on the new leaves of the foodplant(s).

Size = 1.85-1.70 x 1.55-1.50 x 1.50-1.45 mm.

Spf. NOTODONTOIDEA

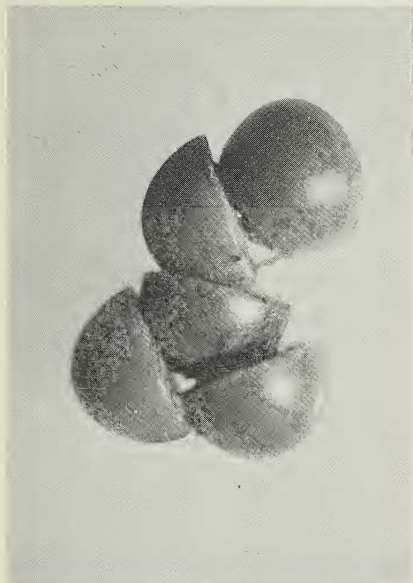
Fam. NOTODONTIDAE

Fig. 10: *Danima banksiae* (Lewin) (det. NM) Nd.15B  
(10 mi. W. of Vivonne Bay, S. coast of Kangaroo Island, South Australia, on the land of G. D. Seton; recorded for most months, but especially late AUG.-OCT.). These large, intensely chalk-white eggs are so conspicuous on the dark green linear leaves of the foodplant that they are quite easily seen with the naked eye from distances of 10 feet and more! They are usually deposited singly. The eggs in the photo were field-collected in mid OCT. 1966. Of about 60 eggs thus collected, 18 proved to be parasitized by a minute black wasp, of which an average of 7 to 10 wasps emerged from each egg, through a single, *small* round exit-hole cut through the side or top of the egg. The small dark spot, on the uppermost egg in the photo, shows the normal appearance of the micropylar area (*not* a wasp exit-hole). The inset shows a partially-eaten shell from which the larva has recently chewed its way to freedom. Note that the shell is uniformly *opaque*, which is *not* a common feature among eggs of the "Macrolepidoptera", except among the Bombycoidea and Notodontidae. When eggs are completely opaque, it is of course, not possible to see any color changes as the larvae develop inside. In the case of *D. banksiae*, the egg remains chalk-white right up to the hour of hatching, even though the young larva emerging from it is black. (See also the seventh paragraph of the paper that follows).

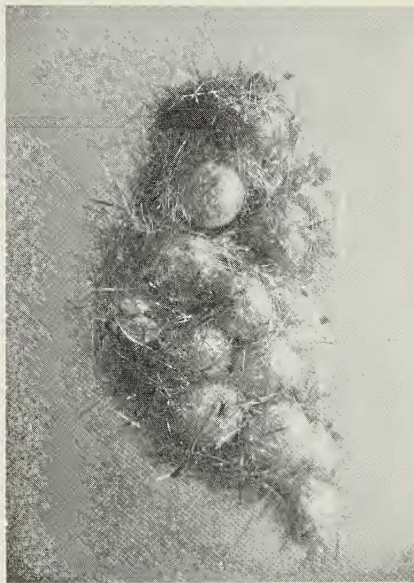
Size (Kangaroo Island population) = 2.00-1.85 x 1.40-1.35 mm.

Fig. 11: *Hylaeora dilucida* Felder (det. IFC) Nd.14  
(Blackwood, South Australia; MAR.-early MAY). These eggs illustrate the most common notodontid egg profile—quite flat on the bottom and evenly dome-shaped above, without ridges or other major surface sculpturing. (Similar egg shapes are seen in many Northern Hemisphere notodontids). The shell is very tough in this species, but *not* opaque. The egg goes through a series of striking color changes during incubation: At first, light pearl-gray (surface glossy), then becoming pale reddish-purple-gray, to rich opaque reddish-purple, to dark gray before hatching. Took 20 days to hatch (autumn).

Size = 2.20 x 1.40-1.30 mm.



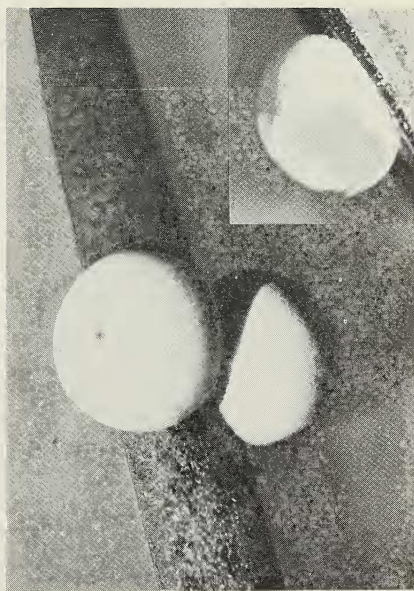
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12



9



10

## Fam. THAUMETOPOEIDAE

Fig. 12: *Epìcoma melanosticta* Donovan (det. IFC) Ta.5  
(Blackwood, South Australia; NOV.-MAY). These eggs are glossy whitish, opaque, and evenly-curving over the top, with flat bottoms, but the lower rim is not sharp. During oviposition they are covered with (and interwoven among) *pale* golden-tan (soft) deciduous scales ("hairs") from the tip of the female's abdomen, which bind them together into a somewhat flexible cluster. There is little or no adhesive involved; the eggs are fairly loose within the soft binding-coat (in contrast with those in Fig. 13, which are securely glued to the substrate in addition to being hair-coated). In the photograph the egg mass is shown as lighted from beneath. Took 19 days to hatch (late summer).

Size =  $0.90-0.85-0.80 \times 0.75-0.70$  mm.

Fig. 13: *Oenosandra boisduvalii* Newman (det. DSF) Ta.1  
(Blackwood, South Australia; mid MAR.-mid MAY). The two eggs shown have been removed from the egg mass typical of this species, which is densely-coated and bristling with dark deciduous scales from the tip of the female's abdomen. Some of the bristling coat still adheres to these eggs, although most has been rubbed off. They are shown standing end-up, as they were glued to one of the strands of muslin upon which the mass (originally of 25 eggs) was deposited. The elongate-cylindrical egg shape, with weak longitudinal grooves, is unusual in the Notodontoidea. Took 35 days to hatch (autumn).

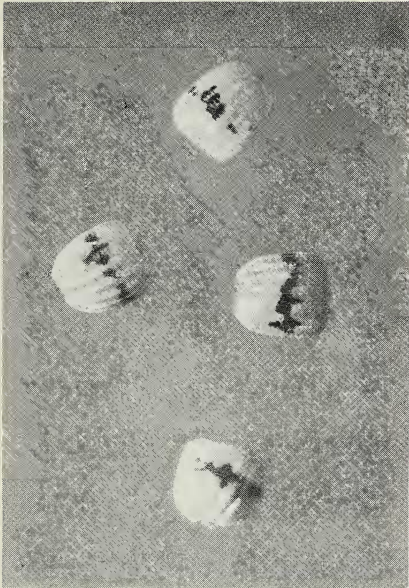
Size =  $1.25-1.20 \times 1.00-0.85$  mm.

Fig. 14: *Discophlebia catocalina* Felder & Rogenhf.  
(det. DSF)

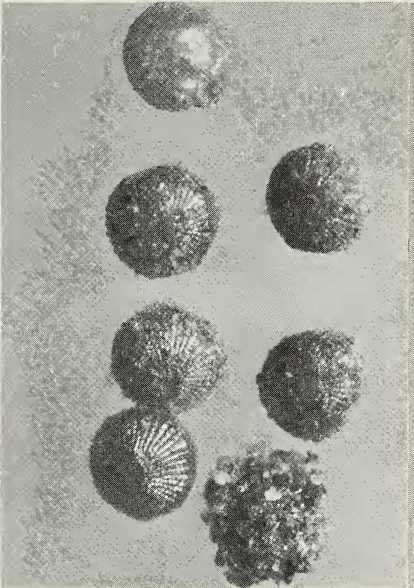
Ta.3

(Blackwood, South Australia; mid NOV.-early FEB.). These eggs are securely glued upright, in short irregular rows and smaller groups (sides usually stuck together), never with any attached scales or "hairs". They are prominently ribbed and very shiny (unusual in the Notodontoidea, with a peculiar, irregular two-tone (internal) color pattern. The lower one-third or one-quarter of the egg is milky-whitish, while the remaining upper area is dark sooty-brown. The two uppermost eggs, and one in the middle, are seen lying on their sides; the other three are standing upright in the way they are deposited. Took 12 days to hatch (summer).

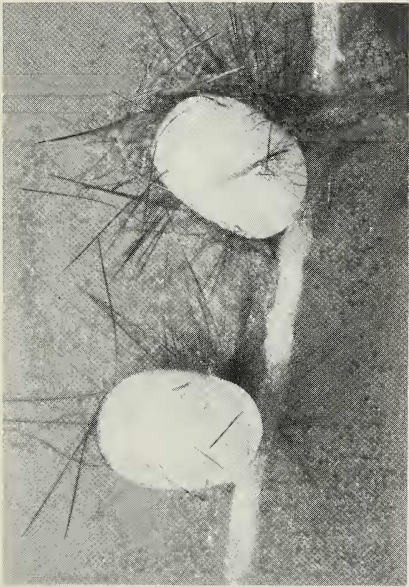
Size =  $1.00 \times 1.00-0.90$  mm.



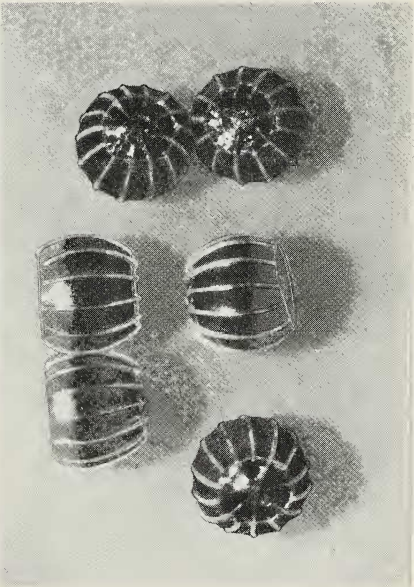
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## Spf. NOCTUOIDEA

## Fam. NOCTUIDAE

Fig. 15: *Cosmodes elegans* Donovan (det. NM) N.110  
(Blackwood, South Australia; OCT.-JUNE). In some respects, the general appearance of this egg is typical of many noctuid eggs. Note the prominent ribs. When first deposited these eggs are pure white. After a day or two, an irregular dark brown band-pattern can be seen developing through the shell as changes take place inside. The eggs of this species are deposited very weakly-glued or unattached.

Size = 0.60-0.55 x 0.55-0.50 mm. (Blackwood); 0.50-0.45 x 0.50-0.45 mm. (Aldgate, S.A.—a considerably cooler and wetter locality in the Mt. Lofty Range, with approx. 40 inches annual rainfall).

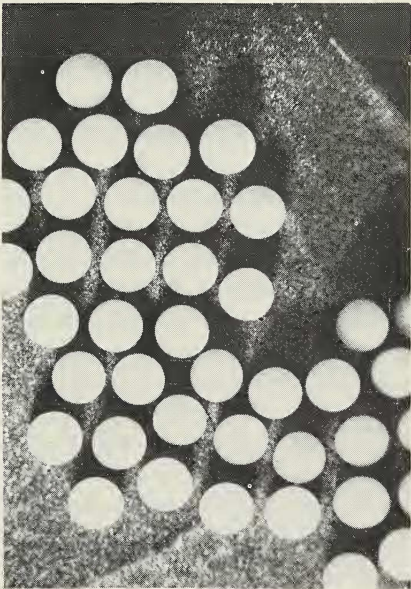
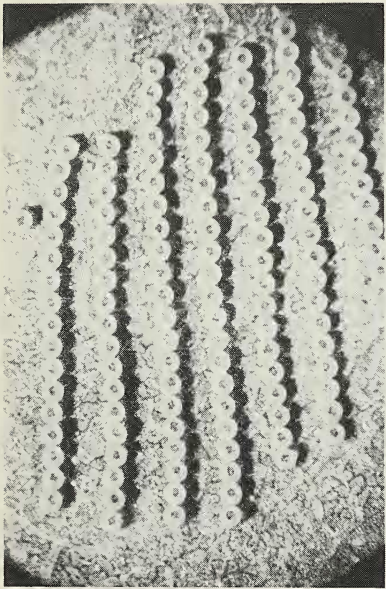
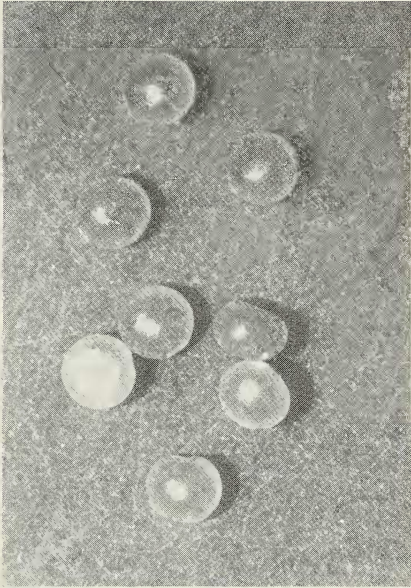
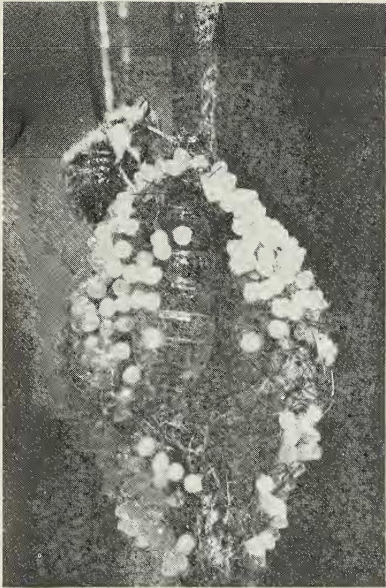
## Fam. AGARISTIDAE

Fig. 16: *Apina callisto* Walker (det. NM) As.8  
(Walkerville, suburb of Adelaide city area, South Australia; mid APR.-mid MAY; adults diurnal). This species seems to occur in very localized colonies, in open grassy-weedy areas (parklands or roadsides, etc.), but can be abundant where present. The behavior of the female during oviposition is most distinctive. Eggs are deposited on the ground, attached to bits of litter or soil particles, etc. (At the time of adult emergence, the annual foodplants are not usually present on the dry ground). Just prior to oviposition, the female crawls along, "dabbling" the tip of her abdomen in dusty-dry soil, picking up fine particles. A few eggs are then deposited, and the first of these will be heavily coated with soil (see one in lower left corner). The soil-dabbling is then repeated during a short walk by the moth, and a few more eggs are deposited. Most of those in the photo have been brushed partially clean, to show the distinctive radiate sculpturing on the upper surface of the shell, but the one at the lower left, with fine sand grains adhering to it, represents the natural condition of a first egg deposited after soil-dabbling. (This may serve as a defense against ants or other soil predators?) The one at the far right shows the smooth and shiny underside, rubbed clean of soil particles.

Size = 0.80-0.75 x 0.60-0.50 mm.

## Fam. NOLIDAE

Fig. 17: *Uraba lugens* (Walker) (det. DSF) N1.2  
(Blackwood, South Australia; OCT.-DEC. and late FEB.-APR.). These eggs were included primarily to illustrate the distinctive oviposition-pattern (neatly-spaced parallel rows); also, to show



the notably transparent central area, typical of many nolid eggs. They are shown as they were deposited, securely glued to the foodplant leaf with a colorless adhesive, and no covering of "hairs". There are sometimes as many as  $10\pm$  rows (of similar length) deposited on one leaf. The young larvae are highly gregarious, feeding closely side by side on a single leaf. As they become larger they gradually disperse. This species often (seasonally) approaches pest status in southeastern Australia, defoliating *Eucalyptus* spp. (Myrtaceae).

Fam. ARCTIIDAE, Sbf. NYCTEMERINAE

Fig. 18: *Nyctemera amica* (White) (det. NM) Ar.39  
(Blackwood, South Australia; recorded for all months, with peaks in JAN-MAR. and MAY-JUNE). These rounded, smooth, shiny eggs are, in general appearance, typical of many arctiid eggs the world over. The color is at first cream-white, with a gleaming, pearly surface-luster. They are flattened on the bottom (where attached), and so are not perfectly round, although they seem to be when viewed from above. It is interesting to note that this species does not deposit its eggs in actual contact with each other, even though they are *very* close together in a mass formation. The precise spacing is always maintained (typical of numerous arctiids). Part of a mass is here shown attached to the surface of the foodplant leaf. Took 6 days to hatch (summer).

Size = 0.70 x 0.60 mm.

Fam. ARCTIIDAE, Sbf. LITHOSIINAE

Fig. 19: *Xanthodule ombrophanes* (Meyrick) Ar.38  
(det. IFC)  
(Blackwood, South Australia; OCT.-NOV. and FEB.-JUNE, reaching a peak in APR.-MAY; only ♂ comes to light, mostly *after* midnight). This photograph is a rather poor copy from a color slide, but was included because it depicts a most unusual form of oviposition among the *Arctiidae*. The flightless (brachypterous) female moth waits on the outside of her cocoon until a flying male locates her (much as in the style of certain lymantriids of the genus *Orgyia*). After mating, the female rapidly deposits the eggs (with no coating of any sort) all over the surface of the cocoon, and then dies. In the photograph, the shrivelled adult female (about to die), having laid all her eggs, is seen clinging to the outside of her cocoon; the thin, shiny and nearly colorless empty pupal shell, from which she had emerged a day or two earlier (with a huge abdomen swollen with eggs),

can be vaguely seen inside the cocoon. The egg shape might best be described as bluntly pyramidal.

Fig. 20: *Scoliacma bicolora* (Boisduval) (det. IFC) Ar.37 (Blackwood, South Australia; OCT.-NOV. and JAN.-mid APR.; the main flight is the spring brood). The eggs in the photo are from Aldgate, S. Aust., in the Mt. Lofty Range not far from Blackwood; Andrew Smith, collector. A unique feature of these small eggs, which are glued in groups close together but *not* touching (much like those in Fig. 18), is their almost water-clear translucence when freshly oviposited. The uppermost egg is turned over, showing the more flattened underside, which has been slightly dented. The second egg from the left, in the lower row, is standing on its edge, showing the lateral profile (its bottom faces to the right). The newly-hatched larvae eat their transparent egg shells almost entirely before dispersing.

Size = 0.55-0.50 x 0.40-0.35 mm.

Figs. 21-48: Entirely of the Family Geometridae

### Spf. GEOMETROIDEA

#### Fam. GEOMETRIDAE

##### Sbf. GEOMETRINAE (Hemitheinae)

Fig. 21: *Hypobapta eugramma* (Lower) (det. IFC) Gm.125 (Blackwood, South Australia; NOV.-early APR.). The intense white parallel lines are in the shell of the egg (opaque), and thus do not change when the internal colors do; the rest of the shell is translucent. The space between these lines becomes vivid reddish-pink after several days, and then changes to dark gray prior to hatching of the larvae. Major color changes are visible in the eggs of most species of geometrids during incubation, as nearly all have (more-or-less) transparent shells. These eggs have been removed from the substrate, but some still remain attached to each other *at odd angles*, which is typical of the oviposition style in this species, at least when in confinement. (A close relative, *H. percomptaria* (Gn.), my Gm.88, deposits a similar but slightly less elongate egg, which entirely lacks the white lines and has, instead, a small but intense white spot at the smaller end). Took 10 days to hatch (summer). See also Figs. 41-42 (S.E.M. photos of this species).

Size = 1.45-1.30 x 0.90-0.80 x 0.75-0.70 mm.

Fig. 22: *Cyneoterpna wilsoni* Felder (det. DSF) Gm.162 (Blackwood, South Australia; AUG.-APR.; reaching a peak from DEC.-FEB.). The photo depicts the eggs as they are often attached, singly or in irregular short stacks (securely glued), at

the tips of small new leaves of the foodplant. They are a pure, pale green when first deposited (surface shiny). Took 8 days to hatch (summer).

Size = 1.10-1.00 x 0.70-0.60 x 0.60-0.50 mm.

Fig. 23: *Eucyclodes buprestaria* Guenée (det. NM) Gm.175A (Aldgate, Mt. Lofty Range, South Australia; OCT.-FEB.). Through the kindness of Andrew Smith, I was given a series of eggs obtained from a confined female in DEC. 1969. Two outstanding features of these eggs, when compared with the eggs of other South Australian Geometrinae, are the sharply-defined *rim*s in combination with the notably *flat* upper and lower surfaces. The photo shows 4 eggs standing on edge and one lying flat (lower left). Color, for most of the incubation period, is a deep yellow. Mostly deposited singly, glued to the foodplant stems or tips. Took 16 days to hatch (summer).

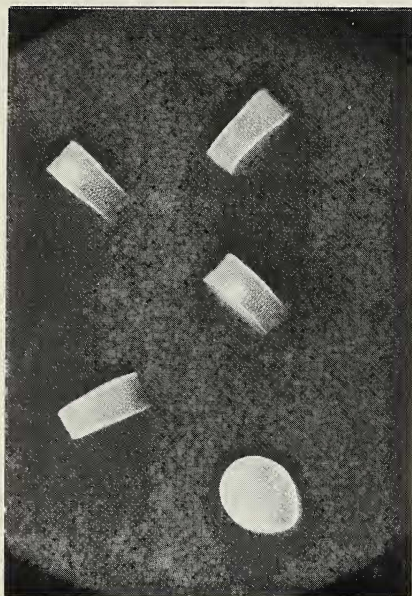
Size = 0.90-0.85-0.80 x 0.70-0.65 x 0.45-0.40-0.35 mm.

#### Fam. GEOMETRIDAE, Sbf. OENOCHROMINAE

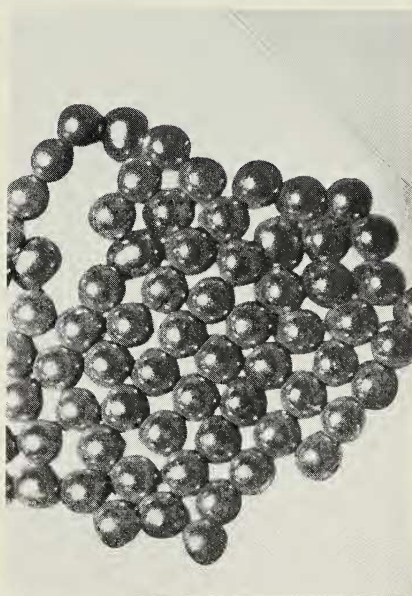
Fig. 24: *Arhodia lasiocamparia* Guenée (det. DSF) G.124 (Blackwood, South Australia; SEP.-mid MAR.). A large single layer mass was deposited by a confined female of this species, with the eggs securely glued to the sides of each other, mostly end up, although three can be seen tipped sideways, near the upper right of the photo. Another species in the same genus (slightly smaller, with more maculation on the forewing, my G.163) deposits its egg mass in the form of an encircling-band around a twig, with no covering substance, somewhat reminiscent of the egg mass type deposited by certain American *Hemileuca* spp. (Saturniidae). It is possible that *A. lasiocamparia* may also deposit an encircling-band, if ovipositing on a twig. My observations are limited to females confined in jars with muslin strips, where they could not have possibly deposited encircling-bands, even if that had been the normal habit. Through all color changes, from dark gray with a faint green tinge to gray-brown to coppery reddish-brown to deep lead gray, there is a gleaming pearly-gold surface sheen on the shell. Took 15 days to hatch.

Size = 0.95-0.90-0.85 x 0.75-0.70 x 0.70-0.65 mm.

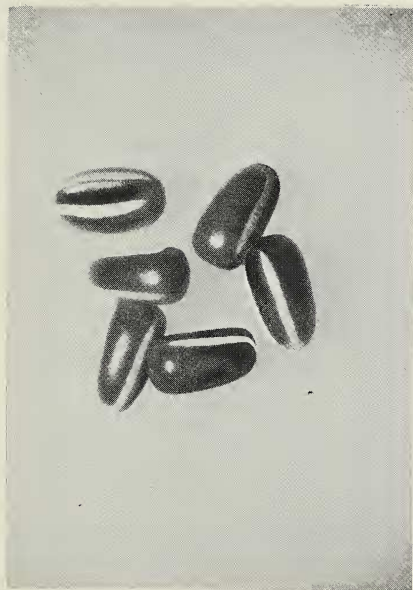
Fig. 25: *Hypographa aristarcha* Prout (det. IFC) G.184 (10 mi. W. of Vivonne Bay, S. coast of Kangaroo Island, South Australia, on the land of G. D. Seton; late AUG.-OCT.). These eggs are deposited singly or irregularly in small clusters (2 or



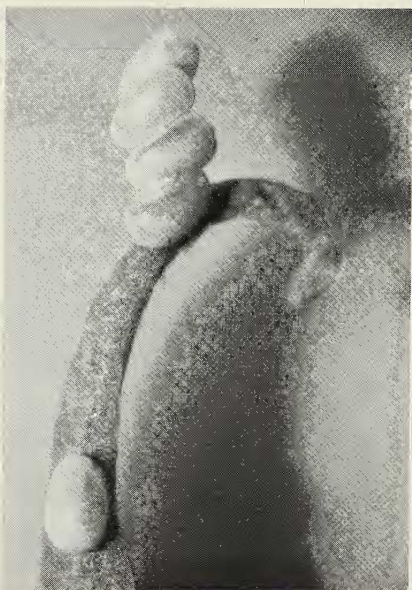
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3), strongly-glued to the foodplant leaves. The superb coloring consists of an irregular speckling in deep blood-red, on a gleaming (shiny) pearl-white background. Prior to hatching, the speckles disappear and the color becomes uniformly blackish (color of the fully-developed larva inside). Took 19 days to hatch (early spring).

Size = 1.10-1.05 x 0.80-0.75 x 0.70 mm.

Fig. 26: *Dinophalus drakei* (Prout) (det. IFC) G.194  
(Near the base of Black Hill, Athelstone, E. of Adelaide, South Australia; late SEP.-OCT.). This species is under the genus *Ophiographa* in the British Mus. (N.H.). Similarities can be seen between the eggs of this species and those of *Hypographa aristarcha*. In the smaller *D. drakei* egg, the speckling is fainter (less intense), more regular in its spacing, and the surface shine is less.

Size = 0.90 x 0.70 x 0.60 mm.

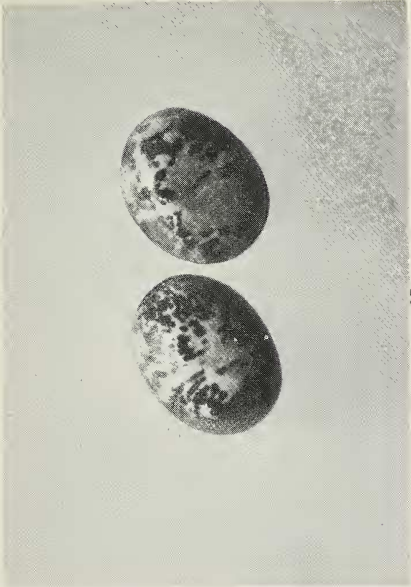
Fig. 27: *Monoctenia smerintharia* Felder (det. DSF) G.94  
(Blackwood, South Australia; late FEB.-APR.). These eggs were included for comparison with those of the next species. Good differences are evident, yet it is easy to see many similarities in the eggs of these two closely-related moths. In this species, the speckling varies from dark red-purple to dark red-brown (on a pale gray background), depending on the age of the eggs. Took 35 days to hatch (autumn).

Size = 1.75-1.65 x 1.40-1.30 x 1.10-1.00 mm.

Fig. 28: *Monoctenia falernaria* Guenée (det. DSF) G.167  
(Blackwood, South Australia; mid MAR.-mid APR.). The middle egg is only a few hours old, and has not yet developed the (internal) speckling, which can be seen through the transparent shells of the other two. Very dark reddish speckles develop, on the pale cream-tan background, after several days. *Not only do these eggs vary exceedingly in size, but also in proportions* (length to width); the series measured were all from one female! These great size differences are instantly apparent, even to the naked eye. Took 14 days to hatch (autumn), a much shorter incubation period than in *M. smerintharia*.

Size = 1.95-1.40 x 1.40-1.15 x 1.10-1.00 mm.

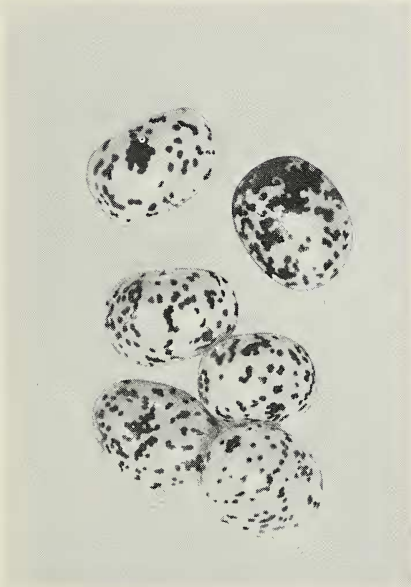
Fig. 29: *Phallaria ophiusaria* Guenée (det. DSF) G.80  
(Blackwood, South Australia; late FEB.-mid MAR.). This is one of the few large geometrids that deposits a very weakly-



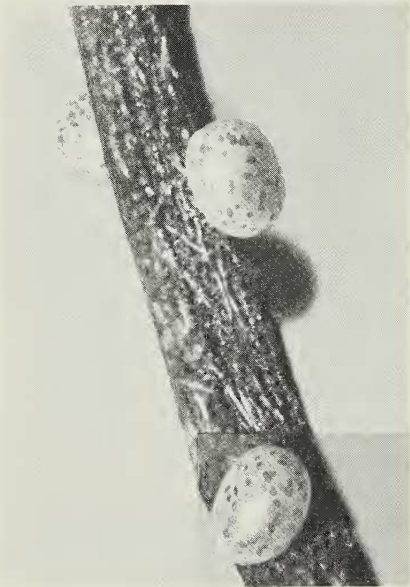
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attached egg, which falls to the ground at the slightest touch. (Essentially, it could be thought of as an unattached egg). The eggs in the photo show a little collapse at the sides, but this only happens later in incubation; when first deposited, they are *almost* perfect spheres and pure white. Red speckles soon develop and darken in a few days. Took between 14 to 22 days to hatch, varying to this extent within a single batch from one female, all of which had been oviposited in a period of two nights. (Possibly this species is on the borderline of a "rain-hatched" tendency? See paper that follows).

Size = 1.25-1.20 x 1.20-1.15 mm.

Fig. 30: *Rhynchopsota rhyncophora* (Lower)  
(det. DSF)

G.127

(Blackwood and Eden Hills, South Australia; late MAY-JUNE). This moth is perhaps best assigned to the Oenochrominae; more larval and pupal material should eventually clarify the matter. With reference to the generic placement of this species (type specimen under "*Chlenias*", in S.A. Museum, Adelaide; under "*Amelora*" in the Brit. Mus.), I quote the following from D. S. Fletcher (Apr. 71): "*Rhynchopsota* is at present included in the generic synonymy of *Amelora* Guest, but is structurally distinct." (This statement is based on a genitalic slide made by Fletcher, of my G.127, in April, 1971). The genus contains one other described species, *R. delogramma* Lower.

A single egg is here shown as attached by the female moth during oviposition, in an axil of a younger stem of the foodplant. Eggs are usually deposited singly (occasionally in twos or threes), in crevices between small flakes on the foodplant stems, or in stem axils, securely glued. Color and maculation of individual eggs varies considerably during incubation. Took 40 days to hatch (winter).

Size = 0.95-0.85 x 0.75-0.65 x 0.55-0.50 mm.

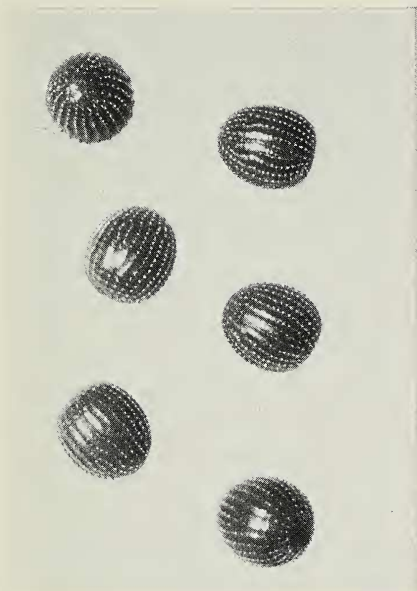
#### Fam. GEOMETRIDAE

##### Sbf. ENNOMINAE (Boarmiinae)

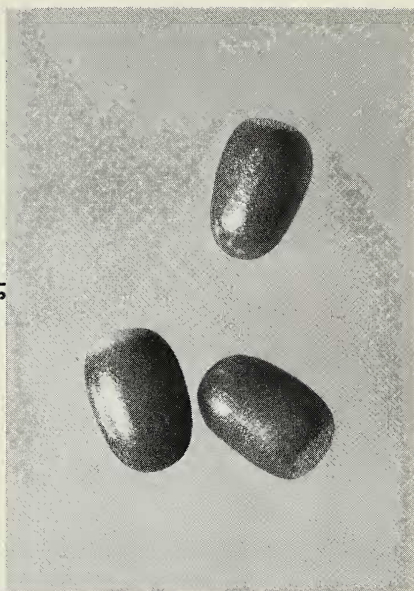
Fig. 31: *Idiodes apicata* Guenée (det. DSF)

G.147

(Blackwood, South Australia; recorded for every month, with peaks in DEC.-JAN. and JULY-AUG.). This species drops its eggs free—entirely unattached. Note the roughly parallel rows of small white "pustules". These white "dots", appearing as white "pustules" at lower magnifications, are actually raised and closely adjoining white rings (mostly paired), and looking



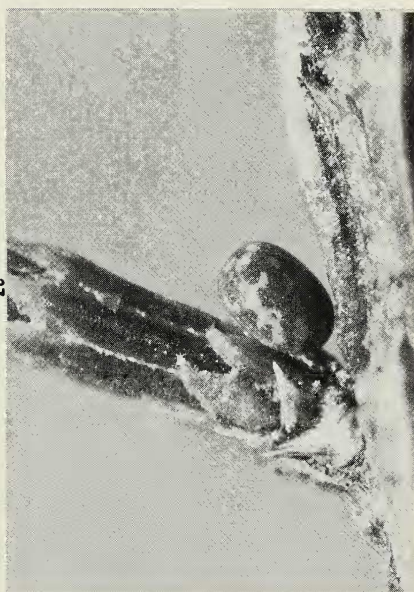
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like the figure-8. These morphological details can be seen clearly in the S.E.M. photos of the egg of this same species (Figs. 45-48). The ground color of this egg is at first cream, then changing to milky-orange, to light pinkish-orange, to deep pinkish-orange (salmon), to gray-brown prior to hatching; through all color changes the "pustules" remain white. A batch of these eggs obtained in JAN. 1969 (mid summer) took 5 to 6 days to hatch; a batch obtained 24 NOV. 65 (early summer) took 8 days; a batch obtained 25 JULY 66 (mid winter) took 19 days to hatch. (In each of these instances the eggs were indoors, in a room not artificially heated or cooled, subject to all natural fluctuations in temperature of the habitat outdoors.)

Size = 0.65-0.60 x 0.60-0.55-0.50 mm.

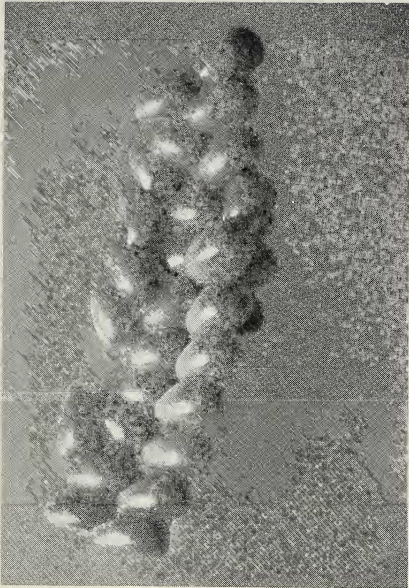
Fig. 32: *Stibaroma melanotoxa* Guest (det. IFC) G.81 (Blackwood, South Australia; late FEB.-MAY). These eggs are usually deposited in long, irregular rows or groups; also some scattered in smaller groups and a few singles (when in confinement). The shape is almost uniformly elongate-cylindrical. At the larger end there is a peculiar area, giving a color-and-texture impression of fine, whitish foam-plastic (sub-surface). (There is a similar appearance to the larger end of the egg of *Thalaina angulosa*, Fig. 38). The eggs of *S. melanotoxa* are at first pale gray with a faint pinkish tinge and a gleaming surface sheen; later in incubation they darken to a deep gray-brown (surface sheen remaining). Took 22 days to hatch (autumn).

Size = 0.90-0.85-0.80 x 0.60-0.55 mm.

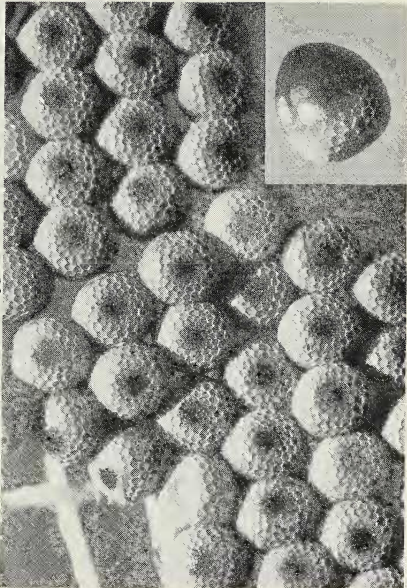
Fig. 33: *Cleora bitaeniaria* (LeGuillou) (det. IFC) G.86 (Blackwood, South Australia; recorded for every month, but somewhat more abundant in SEP., and from DEC.-JUNE). These distinctive eggs are lightly glued on their sides, mostly singly or in small groups or "masses". They go through a sequence of major color changes, as follows: At first dark greenish red-brown, then to uniformly rich red-brown, to translucent dull raspberry-red, to darker before hatching. Took 16 days to hatch (early autumn). See also Figs. 43-44 (S.E.M. photos of this species).

Size = 1.25-1.20-1.05 x 0.70-0.60 x 0.60-0.55 mm.

Fig. 34: *Cleora displicata* Walker (det. DSF) G.165 (Blackwood, South Australia; OCT.-APR., reaching a peak in JAN.-MAR.). The female moth has a long ovipositor, with which she inserts her notably soft-shelled eggs into crevices or under loose bark, on the stems of the foodplant. The egg mass



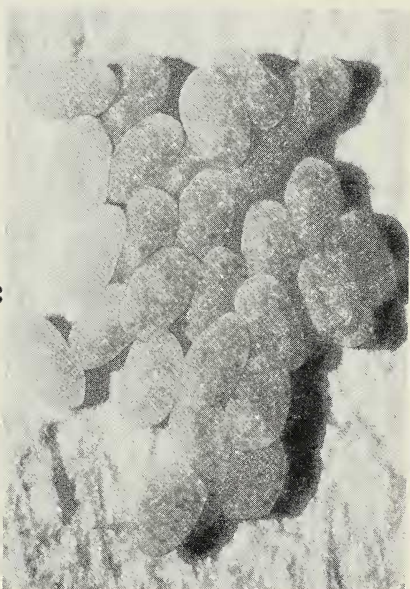
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is irregular and may be more than one layer deep, more-or-less filling (or conforming to) part of the space inside a crevice. Unprotected in the open, these eggs desiccate rather easily. As is well depicted by the photo, the eggs are very pale in color and translucent. They are at first a clear lime-green, later becoming pale yellowish-green, then to yellow-gray, to gray prior to hatching. Took  $\pm 10$  days to hatch (summer).

Size =  $0.80-0.70 \times 0.55-0.50 \times 0.45-0.40$  mm.

Fig. 35: *Mnesampela fucata* (Felder) (det. DSF) G.109  
(Blackwood, South Australia; mid MAR-JUNE). These eggs are deposited in irregular but distinctive masses and strings, often being stacked upward from the surface where they are attached. The adhesive is exceptionally strong and thoroughly waterproof. This is one of the prime examples of a "rain-hatched egg", as well as having "first instar dispersal behavior" strongly developed; these phenomena are discussed at length in the paper that follows.

Size =  $1.30-1.20 \times 0.90-0.85 \times 0.80-0.75$  mm.

Fig. 36: *Capusa cuculoides* Felder (det. DSF) G.105  
(Blackwood, South Australia; late MAY-JULY). Mr. Fletcher (Apr. 71) kindly prepared and compared genitalic slides of *Capusa cuculoides* Felder and *C. stenophara* Turner, and found them to be identical. (This sp. appears under *stenophara* Turner in some Australian collections). The photo shows only a small section of one of the huge, elongate egg masses (deposited by a single female), as seen from above. A single mass sometimes contains more than 300 eggs. The eggs are very securely glued together with a waterproof adhesive. The inset shows one egg (at much greater magnification), detached from the mass and turned on its side. Note that the distinctive net-like surface-sculpturing only extends to less than halfway down from the top, thence fading out; the rest of the egg is smooth and tapered, with the lower section changing in color from pale gray-green to gray-brown during incubation. The resemblance to an acorn cannot be missed! Took 20 days to hatch (winter).

Size =  $0.75-0.70 \times 0.70-0.65$  mm.

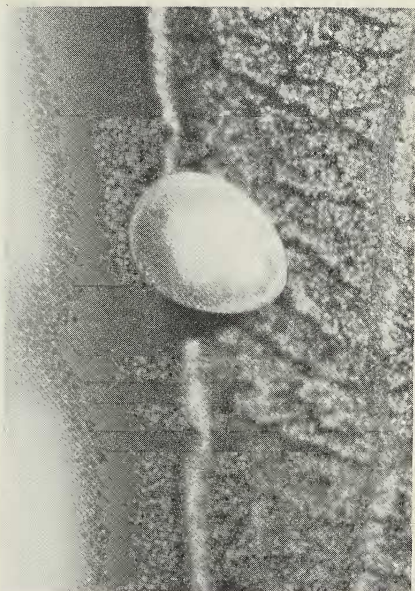
Fig. 37: *Lophothalaina habrocosma* (Lower)  
(det. NM)

G.154

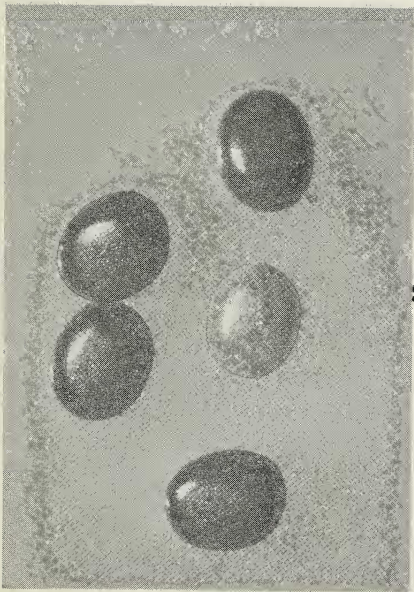
(Blackwood, South Australia; APR.). The type specimen is under "*Pseudopanthera*" in the S.A. Mus. (Adelaide). The eggs of this scarce and distinctive geometrid are glued singly, or in twos (flat side down), to the foodplant leaves. A pitted surface



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texture occupies a clearly-defined zone, in the more central area of the flat upper and lower surfaces of the egg; this is bordered by a relatively smoother area of the shell surface. (The egg at the far left shows this fairly well; note reflected light on the smoother bordering zone). For most of the incubation period, these eggs are a deep yellow-cream centrally, tinged with orange around the edges. Somewhat of a "rain-hatched" tendency was noted in these eggs, but this is apparently not an absolute necessity for successful hatching. Took 13 days to hatch.

Size = 0.90-0.85 x 0.70 x 0.50 mm.

Fig. 38: *Thalaina angulosa* Walker (det. DSF) G.100 (Blackwood, South Australia; mid MAR.-MAY). These eggs are mostly glued singly, or in twos and threes, on leaves and stems of the foodplant. See remarks under *Stibaroma melanotoxa* (Fig. 32) with reference to the appearance of the larger end of this egg. This is another excellent example of a "rain-hatched" egg. The first batch obtained (APR. 65) were kept for 6 weeks before the idea of dipping them in water occurred to me; this caused rapid hatching of all the eggs, which had appeared ready to hatch for *many* days, but not one had hatched prior to this wetting. In the case of some (from the same batch) left entirely dry, there was no sign of hatching long after all of the water-dipped eggs had hatched. (See the paper that follows for a discussion of "rain-hatched eggs"). During incubation, the eggs change in color from opaque pale green to gray-green to gray to light gray-brown.

Size = 1.10-1.00 x 0.80 x 0.60 mm.

Fig. 39: *Melanodes anthracitaria* Guenée (det. DSF) G.161 (Blackwood, South Australia; mid SEP.-DEC.). As these lozenge-shaped eggs mature, a slight concavity develops on the flat surface. The one at the upper right has been balanced on its edge to show the lateral profile. The eggs are deposited flat side down, in irregular but distinctive one-layer "masses" (often large), where *no egg touches another*, even though all are very close together. All eggs are aligned in the same direction within the mass. They are securely-glued with a colorless adhesive. It is probable that the moth oviposits on the (smooth) surfaces of the foodplant leaves under natural conditions. (In a glass jar, it showed a distinct preference for ovipositing on the sides of the jar, even though a muslin strip was provided). Took 11 days to hatch, with most of the larvae emerging between 9:00-10:00 A.M. (spring).

Size = 0.90-0.80 x 0.70-0.60 x 0.50-0.45 mm.

Fig. 40: *Niceteria macrocosma* (Lower) (det. NM) G.200 (Blackwood, South Australia; FEB.-early APR.). The eggs of this relatively uncommon and showy geometrid are securely-glued (singly, or in twos) at the tip, or along the margin, of the foodplant leaf. When seen from the side, the egg profile is a "tapered oval", which becomes thinner toward the small end (shaped much like those of *Mnesampela fucata*, Fig. 35). An irregular, reddish-pink band-like pattern develops around the edges except at the small end. Took 11-12 days to hatch (no wetting required).

Size = 1.35-1.30 x 1.05-0.95 x 0.80-0.75 mm.

Figs. 41-48: These microphotographs, obtained by scanning electron microscopy (SEM) techniques, have been included for comparison with Figs. 21, 33, and 31, respectively, which species they represent. These eight photographs were provided through the kindness of Mr. A. C. Allyn and Dr. L. D. Miller, of the Allyn Museum of Entomology, Sarasota, Florida, U.S.A. All of them are made from *empty* (hatched) egg shells of the species involved.

Figs. 41, 42 (for full data, see also Fig. 21) — *Hypobapta eugramma* (Lower).

Fig. 41: Magnification 65x (Allyn Mus. photo no. 072971-10, mount no. 70; SEM-S1; Dec. 1971).

Fig. 42: 300x (A. M. photo no. 0058, mount no. 70; SEM-U3; Dec. 1971).

*Remarks:* Fig. 41 represents a relatively rigid egg shell, which maintains its shape well—no collapse. (The slight concavity visible on the flattened upper surface is typical of the *H. eugramma* egg shape). The "intense white parallel lines", described under Fig. 21, are not visible here, as the egg shell has been gold-coated prior to making the SEM photos. Note the subtle but definite surface-detail. This egg appears essentially "smooth" at low magnification, or to the naked eye. Fig. 42 shows the surface structure in still greater detail, and also a belt of pores. Particles of debris, in both of these photos, should be ignored.

Figs. 43, 44 (see also Fig. 33) — *Cleora bitaeniaria* (LeGuill.)

Fig. 43: 100x (A. M. photo no. 072971-3, mount no. 67; SEM-S1; Dec. 1971).

Fig. 44: 300x (A. M. photo no. 0059, mount no. 89; SEM-U3; Dec. 1971).

*Remarks:* Fig. 43 shows considerable collapse, due to the frailty of the empty egg shell of this species. Surface structure is seen to be far more intricate than Fig. 33 would lead one to believe; still greater detail is shown in Fig. 44.

Figs. 45-48 (see also Fig. 31) — *Idiodes apicata* Gn.

Fig. 45: 130x (A. M. photo no. 072971-1, mount no. 66; SEM-S-1; Dec. 1971).

Fig. 46: 140x (A. M. photo no. 0039, mount no. 66; SEM-U3; Dec. 1971).

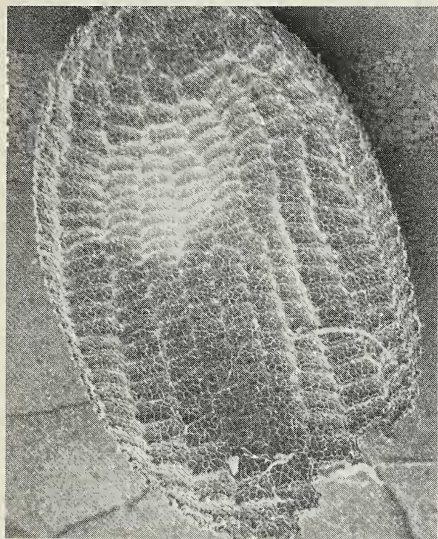
Fig. 47: 1000x (A. M. photo no. 0040, mount no. 66; SEM-U3; Dec. 1971).

Fig. 48: 4000x (A. M. photo no. 0041, mount no. 66; SEM-U3; Dec. 1971).

*Remarks:* Figs. 45-46 show two different views of the empty egg shell, the latter including the micropyle. Due to the frailty of the empty shell of this species, some collapse is evident on the side (Fig. 46). The small white "dots" in parallel rows, appearing merely as small white pustules in Fig. 31, are here seen with far greater accuracy; note that the "pustules" are (mostly) *paired, ring-like, and partially fused* where they contact. Fig. 48 shows one of these paired rings at far greater magnification (data above). Fig. 47 shows detail of the micropylar region.

#### ACKNOWLEDGMENTS

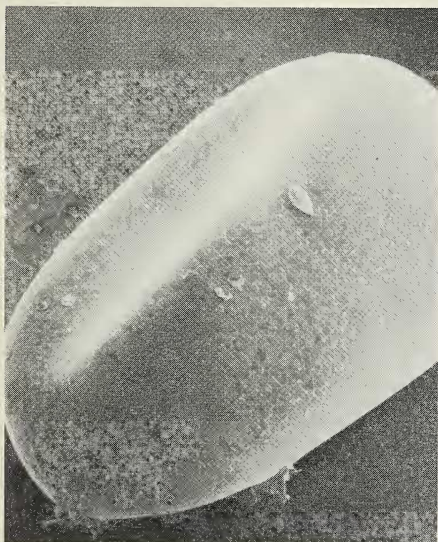
I am indebted to the Trustees of The Australian Museum, Sydney, for permission to use 19 of the first 20 photographs, and parts of the text, which had appeared earlier (as a shorter version) in the magazine, *Australian Natural History* (McFarland, 1970); to R. O. Ruehle (South Australian Museum) for all developing and printing of the photographs used in Figs. 1-40; to I. F. B. Common (C.S.I.R.O., Canberra), D. S. Fletcher and K. Brookes (British Museum of Natural History) for their help with the determinations of many of these species; to A. C. Allyn and L. D. Miller (Allyn Museum of Entomology, Sarasota, Florida) for producing the S.E.M. photos used in Figs. 41-48; to B. K. Head (South Australian Museum) for help with preparation of the black and white prints; to my wife, Dienie, for typing the manuscript; to the Directors and staff of the South Australian Museum (Adelaide), for their encouragement and assistance toward the continuation of this work, during my time there (1965-1970) as Assistant Curator of Insects.



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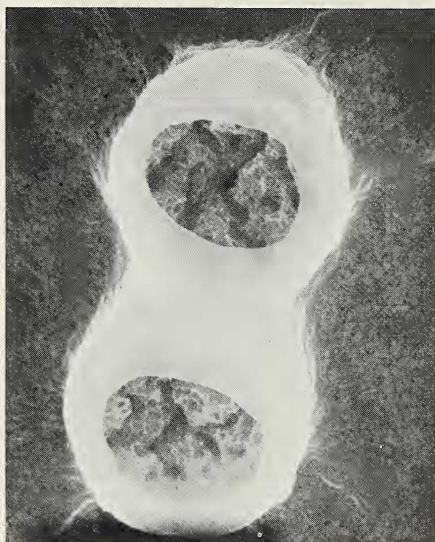
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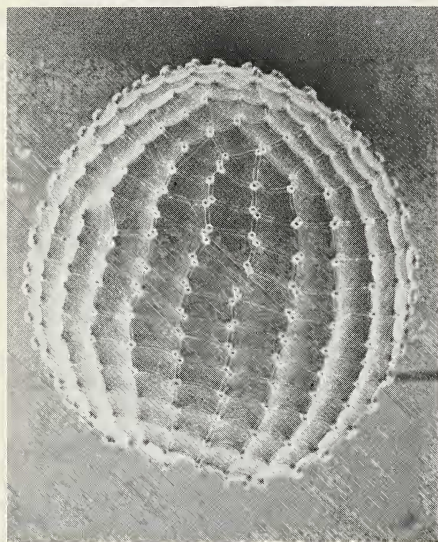
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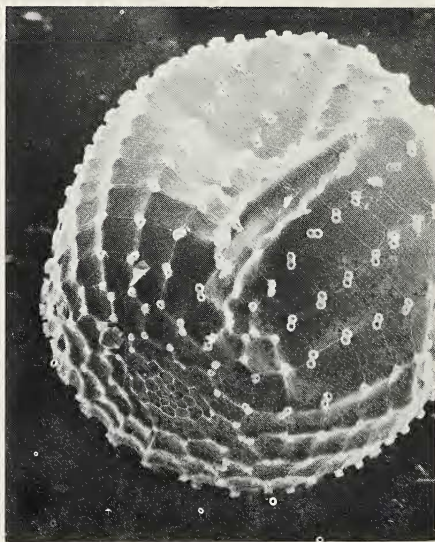
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